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Indian Standard
TEST CODE FOR DISC HARROWS

UDC 631·313·6 : 620·1

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TEST CODE FOR DISC HARROWS

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(*Continued on page* 17)

Indian Standard
TEST CODE FOR DISC HARROWS

0. FOREWORD

0.1 This Indian Standard was adopted by the Indian Standards Institution on 30 April 1975, after the draft finalized by the Agricultural Machinery and Tractors Sectional Committee had been approved by the Agricultural and Food Products Division Council.

0.2 With the fast development of farm mechanization, disc harrows are being increasingly manufactured and used in the country. After the publication of Indian Standard specifications for animal drawn and tractor operated disc harrows, IS : 3606-1972* and IS : 6635-1972† respectively, it was felt that standard procedures should be laid down for testing of harrows. This test code is being issued to serve as a guide for evaluating objectively the performance and constructional durability of disc harrows. This would also help the manufacturers to develop and purchasing agencies to select suitable disc harrows to meet their requirements. However, it is recommended that the test results should not be compared with the tests conducted under different test conditions.

0.3 In the preparation of this standard, considerable assistance has been derived from Government of India Tractor Training and Testing Station, Budni and Farm Machinery Testing Centre of Punjab Agricultural University, Ludhiana.

0.4 In reporting the results of a test or analysis made in accordance with this standard, if the final value, observed or calculated, is to be rounded off, it shall be done in accordance with IS : 2-1960‡.

1. SCOPE

1.1 This standard prescribes the method for testing of disc harrows.

2. TERMINOLOGY

2.1 For the purpose of this standard, the definitions given in IS : 3606-1972* and IS : 6635-1972† shall apply.

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*Specification for disc harrow, animal drawn (*first revision*).

†Specification for tractor operated disc harrows.

‡Rules for rounding off numerical values (*revised*).

3. GENERAL

3.0 The tests recommended in **3.1** and **3.2** shall be carried out in the laboratory and in the field.

3.1 Laboratory Tests — The following tests shall be conducted in the laboratory:

a) Checking of specifications (*see* **5.1**),
b) Checking of material (*see* **5.2**),
c) Testing of disc (*see* **5.3**), and
d) Visual observations (*see* **5.4**).

NOTE — Testing of the disc shall be carried out only if the disc is not marked with the ISI Certification Mark.

3.2 Field Tests

3.2.1 *Short-Run Tests* (*see* **7.1**):

a) Quality of work (*see* **7.1.1**):
  i) Width and depth of cut, and
  ii) Soil pulverization;
b) Power requirement (*see* **7.1.2**);
c) Field efficiency (*see* **7.1.3**):
  i) Effective field capacity,
  ii) Theoretical field capacity, and
  iii) Field efficiency;
d) Ease of operation and adjustments (*see* **7.1.4**); and
e) Soundness of construction (*see* **7.1.5**).

3.2.2 *Long-Run Test* (*see* **7.2**)

4. SELECTION OF SAMPLE FOR TEST

4.1 Selection of Sample — The disc harrow shall be selected at random from the series production by the representative of the testing station with the consent of the manufacturer. It would be the responsibility of the manufacturer to ascertain that the harrow selected for testing is complete in all respects and necessary adjustments have been carried out in the presence of the representative of the testing authority.

4.2 Specifications and Other Literature — The manufacturer shall supply all literature, operational manual and a detailed drawing. The manufacturer shall also supply a specification sheet duly filled in as given in Appendix A. Any other information required for conducting the test should also be supplied by the manufacturer.

5. LABORATORY TESTS

5.1 Checking of Specification — The specifications supplied by the manufacturer as given in Appendix A shall be checked and reported.

5.2 Checking of Material — The material of construction shall be checked and reported in the data sheet prescribed in Appendix B.

5.3 Testing of Disc — The disc shall be tested for the requirements given in IS : 4366 (Part I)-1972*.

5.4 Visual Observations — The observations given in Appendix C shall be assessed visually and reported.

6. SELECTION OF LAND AND PREPARATION OF SAMPLE FOR FIELD TESTS

6.1 Selection of Land

6.1.1 The minimum area of the plot for testing animal drawn disc harrow shall be 0·25 hectare and for tractor operated harrows, one hectare. The ratio of width and length of the plot should be, as far as possible, 1 : 2, and the plot selected should have not been given any previous tillage treatment after the last crop harvested.

6.1.2 The following field conditions of the plot shall be checked and reported:

a) Site of the plot;
b) Type of soil;
c) Last crop grown;
d) Date of last crop harvested;
e) Details of the preceding tillage treatments, if any, after the harvesting of last crop;
f) Topography of the field;
g) Soil moisture percentage;
h) Bulk density of the soil; and
j) Cone index of the soil.

6.2 Preparation of the Sample

6.2.1 The testing authority shall ensure that the harrow has been properly assembled and lubricated after laboratory test.

6.2.2 All the attachments and accessories required for field use shall be fitted in place and the adjustments made shall be in accordance with the manufacturer's recommendations (*see* **4.1**).

---

*Specification for agricultural tillage discs: Part I Concave type (*first revision*).

6.2.3 The harrow shall be properly hitched with the source of power. In case of tractor operated harrows, as far as possible, the same horse power range of tractor should be used for testing as specified by the manufacturer.

7. FIELD TESTS

7.1 Short-Run Tests — At least three series of field tests for short run shall be carried out under different soil conditions. Depending upon the facilities available, additional series of field tests may be conducted. As far as possible the tests should be conducted in the field having optimum soil moisture content for tillage operations. The tests at relatively dry and wet soil conditions may also be carried out depending upon the special features of the harrow.

7.1.1 *Quality of Work*

7.1.1.1 *Width and depth of cut*

a) Set the harrow at minimum operating gang angle as indicated by the manufacturer, at lowest hydraulic position (in case of tractor drawn harrows), and without extra mass. Operate it in the field and cover two or three row lengths.

b) In case the harrow is functioning properly without any trouble, continue the harrowing operation. However, in case of any trouble, first rectify it and then carry out the harrowing operation.

c) Measure the width and depth of cut for maximum 10 places and obtain the average of the reading.

d) Calculate the width of cut (*see* **4.1** of IS : 3606-1972* and **4.1** of IS : 6635-1972†) and compare with the average measured value.

7.1.1.2 *Soil pulverization* — Measure the mean mass diameter (*MMD*) of soil aggregate which will be the index for soil pulverization. The method of determination of *MMD* shall be as follows:

a) Set the harrow in the position described in **7.1.1.1**(a) and operate it in the field.

b) After the harrowing operation is completed, collect the material from an area of 150 × 150 mm and to the depth of harrowing.

c) Weigh accurately the collected material and pass it through a set of sieves with aperture sizes 11·2, 8·0, 5·6, 4·0, 2·8 and 2·0 mm (*see* IS : 460-1962‡).

d) Weigh the material sifted through each sieve and the material sifted and retained on 11·2-mm sieve.

e) Calculate the percentage by mass of material sifted through each sieve and that sifted and retained on 11·2-mm sieve. The material passed through and retained on 11·2-mm sieve should be taken as cent percent.

---

*Specification for disc harrow, animal drawn (*first revision*).

†Specification for tractor operated disc harrows.

‡Specification of test sieves (*revised*).

f) Plot a curve (*see* Fig. 1) with sieve sizes on *X* axis and the percentage of mass of the material sifted through each sieve on *Y* axis.

g) Obtain the area of the shaded portion of the curve by a planimeter.

h) Obtain the mean mass diameter by multiplying the area of the shaded portion with the mass mean diameter equivalent to one unit area in the graph.

NOTE — If the harrow is to be tested on a land already given any previous tillage treatment, the initial *MMD* shall be measured before testing of the harrow. The difference of *MMD* before and after testing gives a relative measure of the soil pulverization.

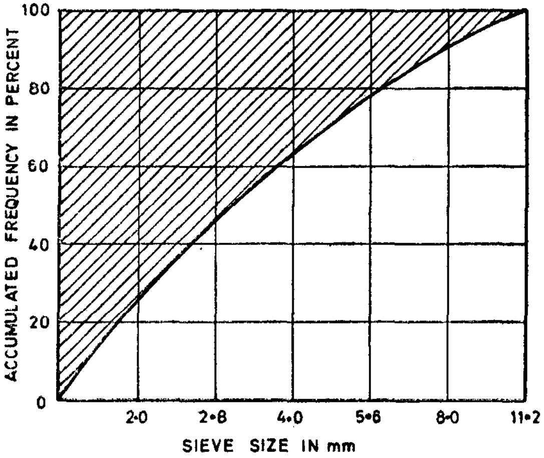

FIG. 1 SOIL PULVERIZATION CURVE

7.1.2 *Power Requirement*

7.1.2.1 *For trailed tractor drawn and animal drawn harrows*

a) Lay off a length of 30 metres in the middle of a long row and mark each end of this space with an easily distinguished pole.

b) Insert a direct-reading spring or hydraulic dynamometer in the hitch to measure the draft in kgf. The draft is defined as the horizontal component of the pull, parallel to the line of motion. If the line of pull through the dynamometer is not horizontal, measure the angle the line of pull makes with the horizontal and calculate the horizontal component (draft) by the following formula:

$$D = P \cos\theta$$

where

D = draft in kgf,
P = pull in kgf, and
θ = angle between the line of pull and the horizontal.

c) Operate the harrow in the positions described in **7.1.1.1**(a). Start the harrow well before the first pole marker and ensure that it operates uniformly when it reaches the pole. As the harrow operates in 30 m space, record 4 to 5 readings of the dynamometer. Work out the average of these readings for obtaining the average draft for the 30 m run. A stop-watch or other accurate time piece should be used to record the time taken by the harrow to traverse the 30 m. Calculate the speed of travel in metre per second from this value.

d) Calculate the drawbar horse power from the following formula:

$$\text{Metric } hp = \frac{\text{Draft in kgf} \times \text{Speed in metre per second}}{75}$$

7.1.2.2 *For mounted tractor drawn harrows*

a) Lay off a length of 30 metres in the middle of a long row and mark each end of this space with an easily distinguished pole.

b) A direct-reading spring or hydraulic type dynamometer should be attached in front of the tractor. Another tractor should be used to pull the tractor to which the harrow is attached.

c) Repeat the operation as in **7.1.2.1**(c).

d) Detach the harrow from the tractor and record the draft required only to pull the tractor (with which the harrow is attached) in the same manner as in **7.1.2.2**(c). Ensure that the tractor is pulled at the same speed as in case of **7.1.2.1**(c).

e) Obtain the draft of the harrow by deducting the draft of the tractor as obtained in **7.1.2.2**(d) from the draft of the harrow and the tractor as obtained in **7.1.2.2**(c).

f) Calculate the drawbar horse power in accordance with the procedure given in **7.1.2.1**(d).

NOTE — In case the facility for strain gauge dynamometer is available for direct reading of the draft, the same should be used and the methods stipulated under **7.1.2.2**(b), (d) and (e) should be overlooked.

7.1.3 *Field Efficiency*

7.1.3.1 *Effective field capacity or output* — The harrow shall be operated for continuous field work for at least 4 hours and the area covered during the period shall be measured in hectares. Calculate the average of output per hour.

7.1.3.2 *Theoretical field capacity* — On the basis of the theoretical width of harrowing and speed, calculate the theoretical field capacity by the following formula:

$$\text{Theoretical field capacity in hectare/h} = \frac{\text{Theoretical width in cm} \times \text{Speed in n/sec} \times 36}{10\,000}$$

7.1.3.3 *Field efficiency* — Calculate the field efficiency as follows:

$$\text{Field efficiency, percent} = \frac{\text{Effective field capacity}}{\text{Theoretical field capacity}} \times 100$$

7.1.4 *Ease of Operation and Adjustments* — Assess and record the observations regarding ease of operation and adjustment during the test.

7.1.5 *Soundness of Construction* — Check the deformation and breakage of parts during the test.

7.1.6 Repeat the above tests at the average and maximum gang angles and for every test conducted (*see* **7.1**). Record the observations given in Appendix D.

7.2 Long-Run Test — The harrow shall be operated for at least 50 hours exclusive of the period covered under short-run tests (*see* **7.1**). If possible, it may be run for 200 hours. The major breakdown, defects developed and repairs made during this period shall be reported in Appendix D.

8. SUMMARY REPORT

8.1 For reducing the data to a usable form, prepare a summary report.

APPENDIX A

(*Clauses* 4.2 *and* 5.1)

SPECIFICATION SHEET

To be filled by
Manufacturer/Testing Engineer

1. General:

- a) Name of the manufacturer
- b) Make
- c) Model
- d) Serial Number

2. Source of Power:

- a) Animal
- b) Tractor
  - 1) Make and model
  - 2) hp range

3. Type of Harrow:

- a) Single action
- b) Double action
  - 1) Off-set
  - 2) Tandem

4. Type of Hitching:

- a) Trailed
- b) Mounted

5. Gangs:

- a) Number of gangs
- b) Number of discs in each gang
- c) Disc spacing
- d) Gang angles
  - 1) Minimum operating angle
  - 2) Maximum angle

6. Concave Discs:

- a) Type
  - 1) Plain
  - 2) Notched
  - 3) Flat centred
- b) Diameter
- c) Thickness
- d) Concavity
- e) Hardness
  - 1) Fully hardened
  - 2) Partially hardened
- f) Centre hole
  - 1) Square
  - 2) Circular with key-way
- g) Type of bevelling
  - 1) Single
  - 2) Stepped
  - 3) Length of bevel
  - 4) Angle of bevel
- h) Notch
  - 1) Number
  - 2) Width
  - 3) Depth
- j) Edge thickness

7. Plain Spool:
- a) Length
- b) End diameters
- c) Axle hole size

8. Bearing Spool:
- a) Length
- b) End diameter
- c) Axle hole size
- d) Method of fixing on axle
- e) Method of fixing to frame

9. Axle:
- a) Type
- b) Size
- c) Length
- d) Method of fixing to frame

10. Bearing:
- a) Type
- b) Size
- c) Whether fitted with oil seal

11. Lubrication:
- a) Type
- b) Recommended lubricant
- c) Recommended periodicity

12. Beam:
- a) Method of attachment
- b) Size
- c) Length

13. Hitching Pin:
- a) Pin diameter
  - 1) Top link
  - 2) Lower link
- b) Pin length
- c) Centre-to-centre distance between holes of hitch points

14. Cross Shaft:
- a) Diameter
- b) Range of side adjustment

15. Mast Height

16. Adjustment:
- a) Angling adjustment
- b) Height adjustment

17. Accessories :

a) Scraper
b) Gauge wheel
c) Transport wheels/arrangement
d) Loading platform

NOTE 1 — The items not applicable to a particular harrow should be struck off while filling in.

NOTE 2 — If any other items are provided, their details should be suitably filled in.

NOTE 3 — Conformity or otherwise of a component with relevant Indian Standard should be mentioned.

APPENDIX B

(*Clause* 5.2)

DATA SHEET FOR MATERIAL OF CONSTRUCTION

1. Date of Test

2. Material

SL No. (1)	COMPONENT (2)	MATERIAL (3)	SIZE (4)	MASS (5)
1.	Frame			
2.	Spool			
3.	Gang axle			
4.	Scraper			
5.	Gang angling mechanism			
6.	Bearing block			
7.	Transport wheel/arrangement			
8.	Loading platform			
9.	Clevis			
10.	Drawbar/hitch			
11.	Bearing			
12.	Seat			
13.	Beam			
14.	Hitch pin			
15.	Middle tine			
16.	Middle shovel			
17.	Bumper			
18.	Any other component			

NOTE 1 — Strike off the component which is not applicable to a particular harrow and add if any other component is provided.

NOTE 2 — Col 4 and 5 should be recorded, wherever feasible.

NOTE 3 — Conformity or otherwise of the material for different components with the requirement as given in relevant Indian Standards should be recorded.

Testing Engineer

APPENDIX C

(*Clause* 5.4)

DATA SHEET FOR VISUAL OBSERVATIONS

1. Observations:

- a) Tightness of bolts and nuts and other fasteners
- b) Adequacy of lubrication of bearings and other moving parts
- c) Provision for transportation
- d) Provision for easy change of components
- e) Adequacy of arrangement to take care of side thrust
- f) Provision for extra load platform and its placement
- g) Provision for attachment of shovel or sweep in the centre of two gangs in case of single action disc harrow
- h) Provision for proper hitching arrangement to any type of source of power

2. Adjustment:

- a) Provision for gang angle adjustment
- b) Provision for hitch adjustment
- c) Provision for scraper adjustment and its cleaning
- d) Provision for loading of gangs

Testing Engineer

APPENDIX D

(*Clauses* 7.1.6 *and* 7.2)

DATA SHEET FOR FIELD TESTS

1. Size of Plot:

- a) Length
- b) Width

2. Field Conditions:

- a) Site of field
- b) Type of soil
- c) Last crop grown
- d) Dates and details of preceding tillage treatments, if any
- e) Topography of the field
- f) Soil moisture percentage
- g) Bulk density of the soil
- h) Cone index of the soil

3. Width and Depth of Cut :

DATE OF TEST (1)	GANG ANGLE (2)	CALCULATED WIDTH (3)	MEASURING PARAMETERS (4)	MEASURING POINTS 1 (5)	2 (6)	3 (7)	4 (8)	5 (9)	6 (10)	7 (11)	8 (12)	AVERAGE MEASURED VALUE (13)
			Width									
			Depth									

4. Soil Pulverization :

DATE OF TEST (1)	INITIAL *MMD* OF SOIL (2)	GANG ANGLE (3)	TOTAL MASS OF MATERIAL TAKEN IN kg (4)	SIEVE SIZE IN mm (5)	MASS OF MATERIAL SIFTED FROM EACH SIEVE IN g (6)	PERCENTAGE OF MATERIAL SIFTED (7)	AREA OF SHADED PORTION OF CURVE (8)	*MMD* (9)
				11·2 8·0 5·6 4·0 2·8 2·0				

5. Power Requirement:

DATE OF TEST (1)	GANG ANGLE (2)	TEST NO. (3)	TIME SPENT TO COVER 30 m RUN IN SECONDS (4)	SPEED m/s (5)	MEASURING POINTS (6)	DRAFT OF HARROW AND TRACTOR IN kgf (7)	DRAFT OF TRACTOR IN kgf (8)	DRAFT OF HARROW IN kgf (9)	METRIC HORSE POWER (10)
					1				
					2				
					3				
					4				
					5				
					Average				

6. Field Efficiency:

Date of Test	Gang Angle	Starting Time	Ending Time	Total time Spent	Idle Period	Net Working Time	Area Covered	Effective Field Capacity	Theoretical Field Capacity	Field Efficiency
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)

7. Other Observations:

a) Uprooting of the weeds
b) Ease of handling
c) Frequent clogging of discs
d) Uniformity of operation
e) Stoppage of source of power at momentary load
f) Stability of hydraulic system
g) Ease of changing of gang angle
h) Any marked breakdown and deformation
j) Any other observations.

Note — Use the same *pro forma* for different tests conducted and for different gang angles.

Testing Engineer

(*Continued from page* 2)

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